FORM PTO-1390 (Modified) (REV 5-93) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 030307/0196

U S APPLICATION NO. (If known, see 37 CFR 1.5): Unassigned 09/787881

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DK99/00508	September 28, 1999	September 28, 1998

TITLE OF INVENTION
PEG-BASED MACROMONOMERS, CHEMICALLY INERT POLYMERS PREPARED THEREFROM AND THE USE OF THESE POLYMERS FOR ORGANIC SYNTHESIS AND ENZYME REACTIONS

APPLICANT(S) FOR DO/EO/US
Morten MELDAL, Jens BUCHARDT and Joerg RADEMANN

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   - ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   - ☐ has been transmitted by the International Bureau.
   - ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   - ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   - ☐ have been transmitted by the International Bureau.
   - ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   - ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).
11. ☐ Applicant claims small entity status under 37 CFR 1.27 .

Items 12. to 17. below concern other document(s) or information included:

12. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
13. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
14. ☒ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ Other items or information:

09787881 ,062201

JC10 Rec'd PCT/PTO 23 MAR 2001

U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/787881 Unassigned	INTERNATIONAL APPLICATION NO. PCT/DK99/00508	ATTORNEY'S DOCKET NUMBER 030307/0196

18. ☒ The following fees are submitted:	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5): Search Report has been prepared by the EPO or JPO.....$860.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482).....$690.00		
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2) $710.00		
Neither international preliminary examination fee (37 CFR 1.482) nor International search fee (37 CFR 1.445(a)(2)) paid to USPTO $1,000.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$860.00	
Surcharge of $130.00 for furnishing the oath or declaration later than 20 Months from the earliest claimed priority date (37 CFR 1.492(e))		

Claims	Number Filed		Included in Basic Fee		Extra Claims		Rate		
Total Claims	20	-	20	=	0	×	$18.00	$0.00	
Independent Claims	3	-	3	=	0	×	$80.00	$0.00	
Multiple dependent claim(s) (if applicable)							$270.00		
TOTAL OF ABOVE CALCULATIONS =								$860.00	
Reduction by ½ for filing by small entity, if applicable.								$0.00	
SUBTOTAL =								$860.00	
Processing fee of $130.00 for furnishing English translation later the 20 months from the earliest claimed priority date (37 CFR 1.492(f). +									
TOTAL NATIONAL FEE =								$860.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +									
TOTAL FEES ENCLOSED =								$860.00	
							Amount to be: refunded	$	
							charged	$	

a. ☒ A check in the amount of $860.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. 19-0741 in the amount of $0.00 to the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 19-0741. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Foley & Lardner
Washington Harbour
3000 K Street, N.W., Suite 500
Washington, D.C. 20007-5109

SIGNATURE (38,665)

NAME STEPHEN A. BENT

REGISTRATION NUMBER 29,768

09/787881

Atty. Dkt. No. 030307/0196

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Morten MELDAL et al.

Title: PEG-BASED MACROMONOMERS, CHEMICALLY INERT POLYMERS PREPARED THEREFROM AND THE USE OF THESE POLYMERS FOR ORGANIC SYNTHESIS AND ENZYME REACTIONS

Appl. No.: Unassigned

Filing Date: 03/23/2001

Examiner: Unassigned

Art Unit: Unassigned

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

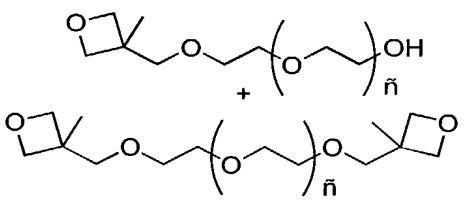
Sir:

In accordance with 37 CFR §1.121, please substitute for original claims 4, 6, 8-12, 14 and 31 the following rewritten versions of the same claims, as amended. The changes are shown explicitly in the attached "Version with Markings to Show Changes Made."

IN THE CLAIMS:

Please delete claims 15-27 and 33.

4. (Amended) A macromonomer according to claim 2 which is terminated by an 3-methyloxetan-3-ylmethyl ether group and has the formula:

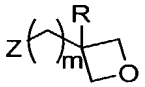


where ñ = 6-300

where m is an integer of 1-10, and

R is H or alkyl or aryl or arylalkyl.

6. (Amended) A process for the preparation of the macromonomers of claim 1 comprising reacting an alkali metal derivative of a polyethylene glycol having 6-300 repeating units with a halo substituted compound having the formula:



where Z is Cl, Br, I, toluenesulfonyloxy or CF_3SO_3

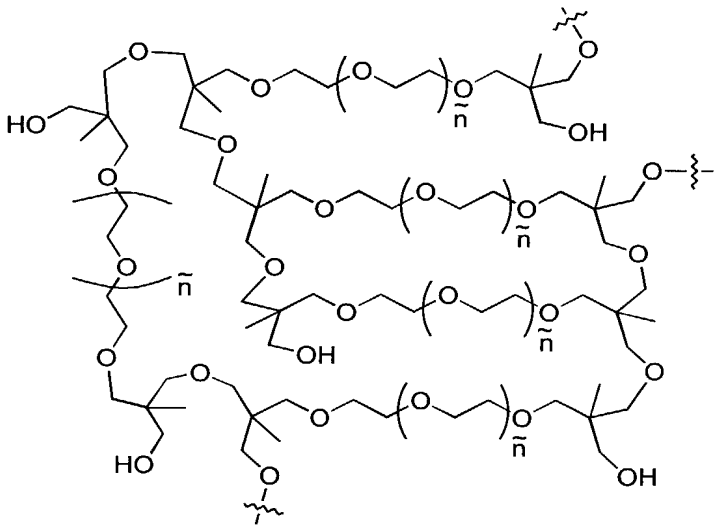
and where m is an integer of 1-10, and R is H or alkyl or aryl or arylalkyl

8. (Amended) A process according to claim 6 wherein the alkali metal derivative is a sodium derivative.

9. (Amended) A process according to claim 6 wherein the alkali metal derivative is a potassium derivative.

10. (Amended) A cross linked polymer formed by the polymerization of a macromonomer according to claim 2.

11. (Amended) A cross linked polymer formed by the polymerization of a macromonomer that has the structure claimed in claim 4, formed by the polymerization wherein the polymerization is initiated by a cationic catalyst and formed by the polymerization of a macromonomer the structure of the polymer is represented by the structure:



where ñ = 6-300

R is H or alkyl or aryl or arylalkyl.

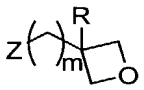
12. (Amended) A crosslinked polymer and formed by the polymerization of a macromonomer that has the structure of claim 5.

14. (Amended) A beaded resin comprised of a polymer according to claim 10.

31. (Amended) A polymer according to claim 10 wherein the polymerization involves a short temporary crosslinker.

Please add the following new claim:

34. (New) A process for the preparation of the macromonomers of claim 2 comprising reacting an alkali metal derivative of a polyethylene glycol having 6-300 repeating units with a halo substituted compound having the formula:



where Z is Cl, Br, I, toluenesulfonyloxy or CF_3SO_3

and where m is an integer of 1-10, and R is H or alkyl or aryl or arylalkyl

Atty. Dkt. No. 030307/0196

REMARKS

Applicants respectfully request that the foregoing amendments to Claims 4, 6, 8, 9, 11, 12, 14 and 31 and new Claim 34 be entered in order to avoid this application incurring a surcharge for the presence of one or more multiple dependent claims.

Respectfully submitted,

Date March 23, 2001

By _____ (28,665)

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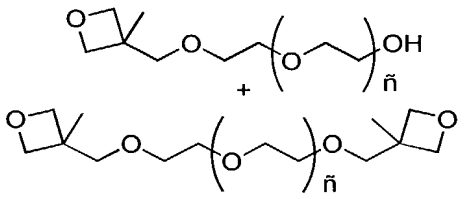
Atty. Dkt. No. 030307/0196

VERSION WITH MARKINGS TO SHOW CHANGES MADE

4. (Amended) A macromonomer according to claim 2 which is terminated by an 3-methyloxetan-3-ylmethyl ether group and has the formula:



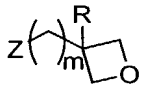
where ñ = 6-300

[where R and m are as defined in claim 1]

where m is an integer of 1-10, and

R is H or alkyl or aryl or arylalkyl.

6. (Amended) A process for the preparation of the macromonomers of [claims 1 or 2] claim 1 comprising reacting an alkali metal derivative of a polyethylene glycol having 6-300 repeating units with a halo substituted compound having the formula:



where Z is Cl, Br, I, toluenesulfonyloxy or CF_3SO_3

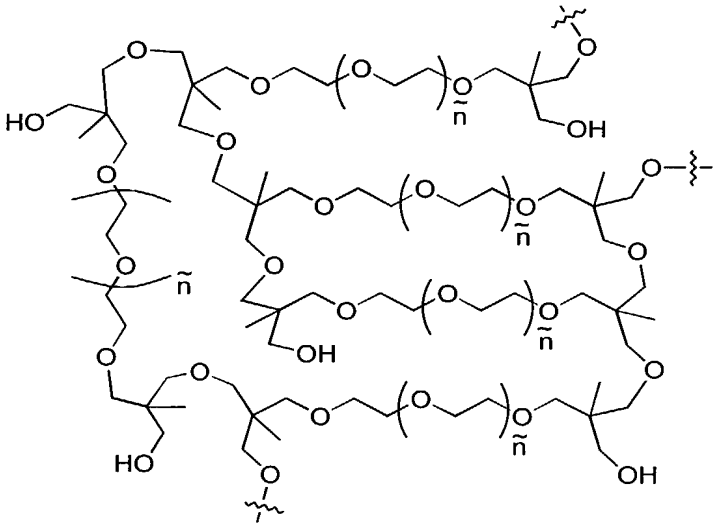
and where m is an integer of 1-10, and R is H or alkyl or aryl or arylalkyl

8. (Amended) A process according to [claims 6 or 7] claim 6 wherein the alkali metal derivative is a sodium derivative.

9. (Amended) A process according to [claims 6 or 7] claim 6 wherein the alkali metal derivative is a potassium derivative.

10. (Amended) A cross linked polymer formed by the [polymerisation] polymerization of a macromonomer according to claim 2.

11. (Amended) A cross linked polymer [according to claim 10 wherein the] formed by the polymerization of a macromonomer that has the structure claimed in claim 4, formed by the polymerization wherein the [polymerisation] polymerization is initiated by a cationic catalyst and formed by the polymerization of a macromonomer the structure of the polymer [may be] is represented by the structure:



where ñ = 6-300

[where R is as defined in claim 1]

R is H or alkyl or aryl or arylalkyl.

12. (Amended) A crosslinked polymer [according to claim 10 wherein the macromer used for its preparation] and formed by the polymerization of a macromonomer that has the structure of claim 5 [and the per-O-acetylated or in other ways temporarily hydroxyl-protected polymer structure analog to the hydroxylated structure of claim 11 is obtained].

14. (Amended) A beaded resin [according to claim 11 or 12 formed by polymerization of droplets in silicon oil] comprised of a polymer according to claim 10.

31. (Amended) A polymer according to claim 10 [with addition of] wherein the polymerization involves a short temporary crosslinker [which may at a later point in time be selectively cleaved to result in expansion of the resin].

PEG-BASED MACROMONOMERS, CHEMICALLY INERT POLYMERS PREPARED THEREFROM AND THE USE OF THESE POLYMERS FOR ORGANIC SYNTHESIS AND ENZYME REACTIONS

FIELD OF THE INVENTION

The present invention relates to macromonomers containing ethylene glycol repeat units, to chemically inert polymers prepared therefrom and to the use of such polymers in solid phase biochemical assays.

BACKGROUND OF THE INVENTION

The use of acrylamide terminated polyethylene glycol in the preparation of cross-linked polymers has been described in International Patent Application No. WO 93/16118 and UK 9609911.4. Such polymers have a particular use as solid supports for the synthesis of peptides, oligonucleotides or oligosaccharides or as substrates for the immobilisation of proteins or as chromatographic resins. They are completely swelled in water and can also used for solid phase enzyme assays. Whilst the polymers so produced were particularly useful as supports for polypeptide synthesis the elimination of the labile bonds in the backbone of the polymer matrix and replacement with more chemically inert bonds allow them to be used as supports for carrying out a large diversity of organic reactions.

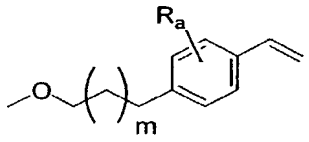
Whereas all previously described PEG-based resins are quite labile to harsh and generally used reaction conditions such as acetic anhydride and Lewis acid, thionyl chloride, butyllithium or potassium hexamethyldisilazan, a polymer containing only

stable primary ether bonds in addition to CH and CC bonds would be completely stable under those conditions.

With the above requirements in mind we have now developed a series of macromonomers of oxethane or vinylphenylpropyl ether terminated polyethylene and polypropylene glycols from which cross-linked resins may be prepared in which the labile bonds in previously described PEG-based polymers are replaced by stable ether linkages whilst retaining the optimised balance of hydrophilic-hydrophobic character.

SUMMARY OF THE INVENTION

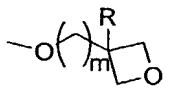
In one aspect the present invention concerns a macromonomer of polyethylene glycol having repeat units in the range 6-200 and having at least one end terminated by an ether group having the formula:



where m is an integer of 0-10, a is an integer of 1-4, and

R is H or alkyl or aryl or arylalkyl;

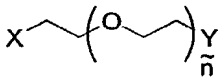
or having the formula



where m is an integer of 1-10, and

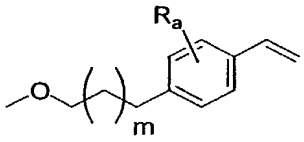
R is H or alkyl or aryl or arylalkyl.

In another aspect the present invention concerns a macromonomer of type A having the structure:



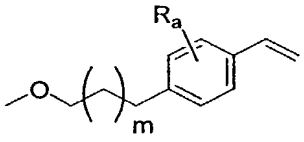
where ñ is a real number of 6-300, and ñ also means the average value of n in the following,

and where X and Y each independently is a group of the formula



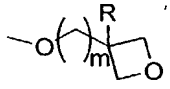
where m is an integer of 0-10, and R is H or alkyl or aryl or arylalkyl,

or where X is –OH, and Y is a group of the formula



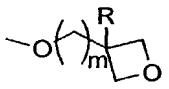
where m is 0-10, a is as defined above, and R is H or alkyl or aryl or arylalkyl,

or where X and Y each independently are a group of the formula



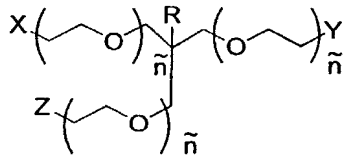
where m is 1-10, and R is H or alkyl or aryl or arylalkyl,

or where X is –OH, and Y is a group of the formula



where m is 1-10, and R is H or alkyl or aryl or arylalkyl.

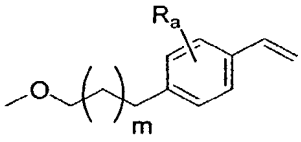
In a further aspect the present invention concerns a macromonomer of type B having the structure:



where R is H or alkyl or aryl or arylalkyl,

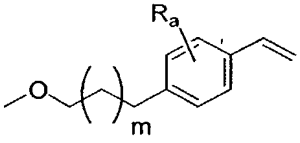
and ñ is a real number of 6-300 as defined above

and where X, Y and Z each independently is OH or a group of the formula



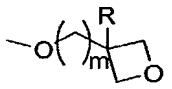
where m is an integer of 0-10, a is as defined above, and R is H or alkyl or aryl or arylalkyl,

provided that at least one of X, Y or Z is a group of the formula



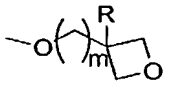
where m is an integer of 0-10, a is as defined above, and R is H or alkyl or aryl or arylalkyl,

or where X, Y and Z each independently is are OH or a group of the formula



where m is an integer of 1-10, a is as defined above, and R is H or alkyl or aryl or arylalkyl,

provided that at least one of X, Y or Z is a group of the formula



where m is an integer of 1-10, a is as defined above, and R is H or alkyl or aryl or arylalkyl.

DETAILED DESCRIPTION OF THE INVENTION

In the present context, the term "alkyl" designates a 1-10 carbon atom aliphatic residue such as methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec.butyl, tert.butyl, pentyl, hexyl, heptyl, octyl, nonyl or decyl. The term "arylalkyl" designates an aryl group linked to a 1-5 carbon atom alkylene chain such as methylene, ethylene or propylene, and the aryl group therein may be of the of the monocyclic or dicyclic aromatic type including normal carbocyclic aromatic types such as phenyl, naphtyl and biphenyl, as well as heterocyclic types such as pyridyl, bipyridyl, imidazolyl, triazolyl, pyrrolyl, bipyrrolyl, thiazolyl and oxazolyl.

The factor "a" as applied to the substituent R indicates that R is present of the phenyl ring a total of "a" times, and that each group R can be selected from the definition of R independently of the other groups R.

The factor "ñ" is as defined above a real number of 6-300 and designates the average number of the ethyleneoxy group in question present in the macromonomer.

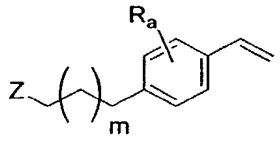
The macromonomers of the invention may conveniently be prepared by reacting an alkali metal derivative, such as a lithium, sodium, potassium or cesium derivative, of the appropriate polyethylene glycol, preferably the sodium derivative, with the appropriate halo substituted, e.g. bromo, chloro or iodo substituted, or arylsulfonate substituted, such as tosyl substituted, vinylphenylalkyl or oxetanylalkyl derivative to yield the corresponding vinylphenylalkyl or oxetanylalkyl capped polyethylene glycol.

The polyethylene glycol may be of the "star" type provided by from tetra to hexa-branching of the macromonomer from e.g. an aromatic or aliphatic carbon atom nucleus substituted with the PEG chains, or of the "T" shaped type where the PEG macromonomer is tri-branched from a tertiary or a quartenary carbon atom

The alkali metal derivative of polyethylene glycol with Li, Na, K or Cs may be formed by reaction with an alkali metal such as sodium, potassium, lithium or an alkali metal hydride e. g. NaH, KH, LiH or by exchange with alkyl- or alkoxy- or other alkali metal salts e. g. BuLi, KOtBu, Cs_2CO_3, KHMDS.

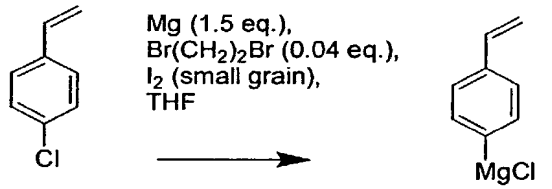
The capped vinylphenylalkyl macromonomers may be polymerised by use of a free-radical initiator, such as an inorganic or organic peroxide, f.x. ammonium persulfate or t-butylperoxide or metacloroperbenzoic acid or AIBN, to yield a cross-linked resin. Similarly, the oxetanylalkyl capped macromonomers may be polymerised by the use of a cationic catalyst such as for exampel $Et_2O:BF_3$, TMSOTf, TfOH, TMSBr, TMSI, $TiCl_4$ or $ZnBr_2$ salts or halides and other salts of hafnium, yttrium, tantal and iron to yield a cross-linked resin.

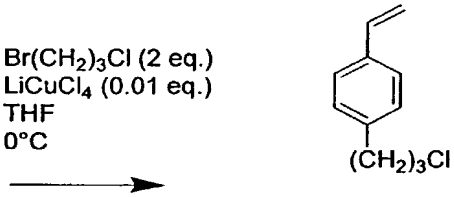
In yet a further aspect, the invention concerns a cross-linked polymer formed by the bulk polymerisation of the products of the reaction between mono- and di- alkali metal derivatives of polyethylene glycol with a vinylphenylalkyl derivative having the formula:

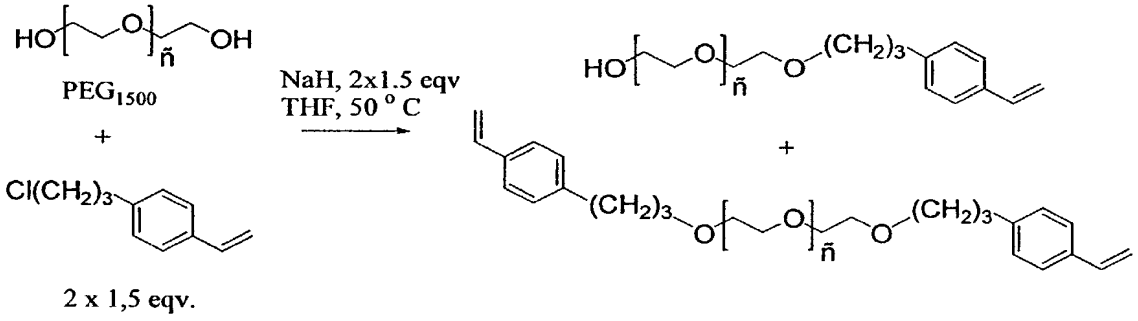


where Z is Cl, Br, I, toluenesulfonyloxy CH_3SO_3 or CF_3SO_3,
a is an integer of 1-4, and m is an integer of 0-10, and R is H or alkyl or aryl or arylalkyl.

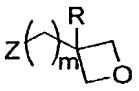
The synthesis of a compound of this class may for example be achieved in the following way:







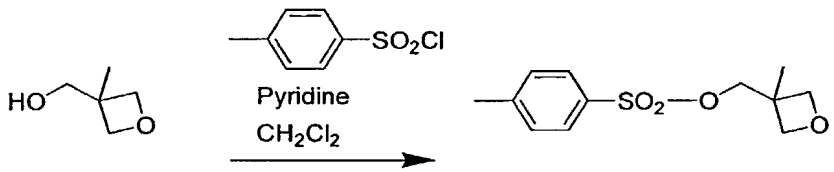
In yet a further aspect the invention concerns a cross-linked polymer formed by the bulk polymerisation of the products of the reaction between mono- and di- alkali derivatives of polyethylene glycol with an oxetane or oxetanylalkyl derivative having the formula:



where Z is Cl, Br, I, toluenesulfonyloxy, CH_3SO_3 or CF_3SO_3,

m is an integer of 1-10, and R is H or alkyl or aryl or arylalkyl.

Members of this compound class may for example be prepared in the following manner:



In the drawings,

The oxethan derived polymer may be prepared in a beaded form neat or by dissolving the oxetanylated macromonomer in a volume of a solvent (e. g. acetonitrile) and suspending the mixture in silicon oil in the presence of a surfactant, typically a polymer obtained from radical polymerization of methacryloxypropylpentamethyldisiloxane and methacryloyl PEG 350 monomethylether. The Lewis acid BF_3 is added at low temperature just before suspension in the oil.

The polymer may be modified by a temporary crosslinker which is selectively cleaved at a later point in time to give a more expandable polymer. This is typically achieved by incorporation of (bis-(3-methyl-3-oxetanylmethoxy)-2-buten and later the doublebond is cleaved by ozonolysis or ruthenium catalyzed methatesis reaction using an excess of ethylene.

Figure 1 is a schematic representation of the reactions involved in the preparation of vinylphenylalkyl ether capped polyethylene glycol and oxetane capped polyethylene glycol macromonomers.

Figure 2 is a representation of the cross-linked resin obtained by polymerisation of vinylphenylalkyl ether capped polyethylene glycol.

Figure 3 is a representation of the resin obtained by the polymerisation of oxetane capped polyethylene glycol.

Figure 4 is a gel phase ^{13}C NMR trace of the cross-linked polymer of Figure 2 derivatized by Fmoc-Gly.

Figure 5 is a magic angle spinning solid phase ^{1}H-NMR trace with selective irradiation at 3.67 ppm to suppress the PEG signal of the cross-linked polymer of Figure 2 after acylation with Fmoc-Gly. Resolved spectra were obtained and similar results were obtained with the resin in Figure 3 in MAS solid phase ^{1}H-NMR spectroscopy.

Figure 6 is a gel phase ^{13}C-NMR trace of the cross-linked polymer of Figure 3.

Figure 7 Shows organic reactions which have been successful on resin prepared by polymerization of 3-methyloxetan-3-ylmethyl derivatised macromonomers.

Figure 8 Illustrates a solid phase enzyme assay in which a fluorescence quenched substrate bound to a resin prepared from vinylphenylpropyl-PEG macromonomers is cleaved for 1 h by subtilisin Carlsberg migrating through the polymer network. The same result was obtained with the SPOCC polymer.

Figure 9 Shows a beaded SPOCC resin obtained by polymerization in silicon oil.

The following examples illustrate the present invention.

Example 1

3-Methyl-3-(4-toluenesulfonoxymethyl)-oxetane. 4-Toluene sulfonyl chloride (20 g, 105 mmol) was dissolved in CH_2Cl_2 (50mL) and pyridine (50 mL). Under cooling in an ice bath, 3-hydroxymethyl-3-methyl-oxetane (100 mmol, 9.9mL) was added dropwise. The reaction was warmed to room temperature over night. It was diluted with CH_2Cl_2 (100mL) and extracted with water. The organic phase was dried with magnesium sulfate filtered and solvents were removed by evaporation. The remainders were coevaporated several times with toluene to remove the remaining pyridine and with chloroform to remove the toluene. The obtained crude product was of sufficient purity for further use. Yield: 22 g of a white crystalline solid (92 %). TLC: Rf (petroleum ether/ethyl acetate 1:1): 0.56. The spectroscopic data were in accordance with literature (Dale, J.; Fredriksen, S.B. *Act.Chem.Scand.B* **1992**, *46*, 271-277).

Example 2

Bis-oxytanylated polyethylene glycol (bis-(3-methyl-3-oxetanylmethoxy)-PEG. Polyethylene glycol (-400 or -1500; 10 mmol) was dried carefully by coevaporation of water with toluene. Then it was dissolved in toluene and DMF (each 15 mL). Under stirring potassium hexamethyldisilazan (KHMDS) (22 mmol) was added at room temperature, after 15 min the solvents were removed together with HMDS at 50 °C waterbath with the rotary evaporator. The remaining potassiated PEG was redissolved in DMF (15mL). The tosylated oxetane derivative (24 mmol) was added in portions at room temperature and the reaction was heated for 12 hrs to 75 °C. After cooling to ambient temperature water (2mL) was added and stirred for 15 min in order to fully hydrolyze unreacted alkylating agent. The solvents were removed at 40 °C under reduced pressure. The remaining slurry was resuspended in CH_2Cl_2 and filtered through a layer of kieselguhr (Celite) (2 cm of kieselguhr on a glass filter, wetted with organic solvent and compressed) and finally evaporated to dryness. Yield: 90 % of 2a. The NMR of the acetylated product indicated the alkylation of > 95 % of the PEG-hydroxy groups with oxetane rings.

When reduced excess of the alkylating reagents 3 was employed (15 and 18 mmol) the percentage of oxetanyl group was decreased (66 %, 80 %).

Example 3

Acetylation of mixtures of mono- and bis-oxytanylated PEG .

Reaction mixture from Example 2 (10 g) was dissolved in pyridine (20mL). Acetic anhydride (10mL) was added and the reaction was stirred at room temperature for

24 h. Solvents were removed under reduced pressure and the degree of acetylation was quantified by ^{1}H-NMR.

Example 4

SPOCC-Resin formed by polymerization of oxetanylated PEG.

Procedure A.: Oxetanylated PEG-1500 or -400 (1 to 20 mmol) prepared as in Example 2 or the acetylated derivative from Example 3 was dissolved under argon in an equal volume of CH_2Cl_2, cooled to –20 °C, and stirred with a magnetic stirrbar. Boron trifluoride diethyletherate (0.15 to 0.3 equiv.) was added. Warming was conducted gradually in order to determine the temperature at which polymerization occurs (-10 °C, 2 h; 0 °C, 2 h; 4 °C, 2 h). Finally, the viscosity of the solution increased and magnetic stirring stopped (sticky point). The sticky point was reached after the solution was kept at 4 °C for 30 min. The polymer was stored at this temperature (2 d) and an additional day at room temperature. For work-up the polymer was cut into pieces. These were swollen (CH_2Cl_2, 2 h) and then granulated through a metal sieve (1 mm pore size) employing a pestle. The granulated resin was washed carefully (CH_2Cl_2, THF, DMF, water, DMF, THF, CH_2Cl_2) and dried *in vacuo*. Resin loading and the swelling volumes in different solvents were determined. The hydroxyl group capacity of the polymers was determined by esterification with fluorenylmethyloxycarbonyl (Fmoc)-Gly using the MSNT method (Tetrahedron Letters 1988, 29, 5871-5874) and measuring the UV-absorbence of the adduct of dibenzofulvene and piperidine formed by treatment of a weighted polymer sample with 20% piperidine/DMF. 0.6

The swelling capacity of the polymer product was determined by the syringe method (Azanneau, F.I., et al. J. Peptide Sci., 1995, 1, 31-44). The swelling volumes of the polymer was 11 mL/g in DMF; 12 mL/g in methylene dichloride and 14 mL/g in water respectively.

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Example 5

SPOCC-Resin formed by polymerization of oxetanylated PEG. Procedure B.: Oxetanylated PEG-1500 from Example 3 was dissolved in CH_2Cl_2 (1 mL/g monomer) 10 and cooled to 0 °C. Lewis acid catalyst BF_3OEt_2 was added (0.4 eq.). It was warmed to room temperature and the sticky point was reached after 10 min, as indicated by increased viscosity halting the magnetic stirrer. After stirring stopped the reaction was warmed to 60 °C for 2 d. After cooling to room temperature work-up was conducted as described under procedure A.

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Example 6

SPOCC-Resin formed by polymerization of oxetanylated PEG.

Procedure C.: Oxytanylated PEG-400 from Example 2 was dissolved in diglyme 20 (1mL/g monomer) and stirred at room temperature. BF_3OEt_2 was added slowly and stirring stopped after 1 min. The reaction was warmed to 70 ° for two d. After cooling to room temperature work-up was conducted as described under procedure A.

Loadings and swelling obtained with resins prepared in Examples 4-6 are presented in table 1 and it is clear that the best polymerization is obtained with acetylated macromonomers.

Table 1.

PEG Length	Oxetane (%)	-OR	Protocol	loading	swelling: H_2O	DMF	CH_2Cl_2
400	> 95	-H	A	0.6			
400	>95	-Ac	B	0.4	2.6	2.3	3.3
400	70	-Ac	B	1.2			
1500	>95	-H	A	0.4	43	37	54
1500	>95	-Ac	C	0.3	10	8	13.5

Example 7

Bis-vinylphenylpropyl-polyethylene glycol(1500):

Anhydrous (Harris, J. M. J. Macromol. Sci., Rev. Macromol. Chem. Phys. 1985;C25:325-373.) PEG_{1500} (12.4 g) was dissolved in THF (25 mL) under Ar at 50°C and NaH (497 mg, 60% in oil, 1.5 eq.) was added. After 5 min. Vinylphenylpropylchloride (2.2 mL, 1.5 eq.) was added over a period of 15 min. Addition of NaH/vinylphenylpropylchloride (1.5 eq. each) was repeated after 3 h and again NaH (1.5 eq.) was added after 6 h. The brown mixture was stirred for another 16 h, concentrated, dissolved in water (75 mL), neutralized, water (125 mL) was added and the solution washed with light petroleum (50 mL). Concentration of the water phase and subsequent coevaporation with toluene (3x35 mL) gave a brown,

opaque residue which was dissolved in CH_2Cl_2 (150 mL) and dried with $MgSO_4$ (35 g). Filtration through Celite and concentration to dryness yielded 13.1 g light brown solid (94%), pure according to proton NMR.

Example 8

Polymerisation of *bis*-vinylphenylpropyl-polyethylene glycol(1500):

Resin from vinylphenylpropyl substitutet PEG (1500) synthesized in Example 7 was prepared in beaded form by inverse supension polymerisation of the vinylphenylpropyl substitutet PEG (1500) (12.6 g) at 70°C for 2.5 h using $(NH_4)_2S_2O_8$ (148 mg, 0.07 eq.), tetramethyl ethylenediamine (443 µL, 0.32 eq), sorbitan monolaurate (133 mg) and a polymerization procedure described previously .(Auzanneau, F.-I.; Meldal, M., and Bock, K., J. Pept. Sci., 1995, 1, 31-44.) 120 g carbon tetrachloride and 80g n-heptane were mixed in a polymerizer and purged with nitrogen for twenty minutes and warmed to 70°C. A solution of the product from Example 7 (12.6 g) in 30 g water together with 0.148 g $K_2S_2O_8$ was purged with nitrogen and poured into the organic phase and stirred at 650 rpm. After 2 min tetramethylethylene dianine (443 µL, 0.32 eq.) was added. Polymerisation was allowed to proceed for five hours at 70 °C at the end of which time the reaction mixture was filtered, the beads washed with methanol and dried under vacuum. The dried particles were sized at 70-400 µm in diameter. Yield: 65%.

Example 9

Polymerisation of *bis*-vinylphenylpropyl-polyethylene glycol(1500):

Alternatively the resins were prepared by bulk polymerisation in water at r.t. for 24 h using $(NH_4)_2S_2O_8$ (0.06 eq.) and tetramethyl ethylenediamine (0.25 eq.) followed by granulation, sieving, washing and lyophilization. Yields: 71%. The loading and swelling was determined as described in Example 4: Loading: 0.22 mmol/g. Swelling: 4 mL/g (DMF), 4 mL/g (H_2O), 6 mL/g (CH_2Cl_2)

Example 10

The macromonomers of the present invention can be co-polymerised with other monomers to vary the properties in the final polymer. The products from Example 7 can be co-polymerised with many monomers capable of free radical polymerisation, for example styrene, divinylbenzene, methacrylates, acrylates and acrylamides. However, co-monomers for the macronomomer products of Example 7 are restricted to oxetane-containing monomers.

Example 11

Macropolymers of the type produced by the polymerisation of the macromonomers of Examples 2-3 and 7 are both expected to be chemically stable and inert, but to have different respective physical properties. For example under hydrogeneolitic, strongly basic or strongly acidic conditions both resins are fully stable. They have, however different preference for solvents of swelling. In contrast to previously reported PEG-

based resins, the resins of the present invention are stable for extented periods of time to thionylchloride, 6 N HCl, TMS-Br, TMS-OTf and Ac_2O, conc KOH, KHDMS/CH_2Cl_2 and 3 mM BuLi.

The main advantages of the polymers obtained from macromonomers of the present invention are the lack of functional groups such as amides in the polymer backbone, high capacity, optimum hydrophilic/hydrophobic balance and high mechanical and in particular chemical stability. The polymers are cost-effective as they are readily prepared using available low-cost bio-compatible polyethylene glycols. The hydroxyl groups of the polymers are amenable to a wide range of functional group transformations without effecting the polymer backbone. The macropolymer resins have an open structure that allow enzymes to penetrate into the interior of the polymer network under aqueous conditions. In addition to their excellent synthesis properties they are therefore suited for performing solid phase enzyme assays using fluorescence quenched substrates or a combination of fluorescence quenched substrates and inhibitors both attached to the polymer. In particular the resin can be used in combinatorial organic synthesis of substrates and inhibitors by the split and combine method, followed by solid phase high throughput screening by exposure to enzymes and inspection of reaction development. The structure of the polymers provides excellent flow properties and reagent or solvent accessibility under organic reaction conditions.

The functional group modification is illustrated in the following examples where the hydroxyl groups are converted into bromides or amino groups.

Example 12

Bromo-SPOCC-resin

Resin from Example 4 (1 g, 0.6 mmol) was suspended in CH_2Cl_2 (10 mL). Triphenylphosphine (787 mg, 5 eq.) and imidazol (204 mg, 5 eq.) were added. After complete disolvation it was cooled in a water bath to 10 °C and bromine was added dropwise (155 l, 5 eq.). Subsequently the water bath was removed and it was stirred over night at room temperature. The resin was filtered and washed with DMF, water, DMF, THF, and CH_2Cl_2. Elemental analysis afforded a bromine content of 0.86 mmol/g resin.

Example 13

Amino-SPOCC-resin.

Resin from Example 4 (1 g, 0.6 mmol) was suspended in a solution of sodium azide in DMSO (390 mmol, 10 eq., 10 mL). The mixture was warmed to 60 °C for a period of 18 h. The resin was filtered and washed extensively with DMF, water and DMF. Reduction was effected employing 1,4-dithio-threitole (DTT) in combination with 1,8-diazabicyclo[5.4.0]undenc-7-ene (DBU) (10 mL of a 0.5 M solution of DTT in DMF, containing 0.1 M of DBU). The resin was filtered and washed with DMF, THF, and CH_2Cl_2. Resin loading was determined by spectrophotometrical measurement of Fmoc-cleavage after functionalization of a resin sample with Fmoc-succinimide (10 eq., 4 h). Measured loading: 0.44 mmol/g.

The usefulness of the polymers obtained from the macromonomers of the present invention for organic synthesis and simultaneous compatibility with aqueous conditions are illustrated in the following examples:

Example 14

p-[-(*L*-Seryl-*L*-phenylalanyl-*L*-leucyl-glycylamido)-2,4-dimethoxy benzyl]-phenoxyacetylamido-SPOCC-resin

SPOCC-resin (210 mg, 0.1 mmol) was functionalized with the Fmoc-protected Rink-linker. (208 mg linker, 0.4 eq) was dissolved together with TBTU (122 mg, 0.38 mmol) and N-ethylmorpholine (NEM) (83 L, 0.5 mmol) in DMF (3 mL) and after 10 min added to the resin for 3 h. After washing with DMF (5 times) the Fmoc-group was cleaved (20 % piperidine in DMF, 2 and 16 min). The deprotected amine functionality was acylated with Fmoc-amino acids (3 eq. of Fmoc-Gly-OH, Fmoc-Leu-OH, Fmoc-Phe-OH, and Fmoc-Ser-OH) which were activated with TBTU (93 mg, 0.29 mmol) and NEM (66 l, 0.4 mmol) as described for the linker and also coupled for 3 h each. After final Fmoc-deprotection the product was cleaved of a resin sample (2 mg, 95 % TFA, 2h) and analyzed by HPLC and MALDI-MS. r.t. = 24.0 min. MALDI-MS: Calc.($M = C_{20}H_{31}N_5O_5$). Found (MH^+, MNa^+, MK^+): 422 m/z, 444 m/z, 460 m/z. The final loading was 0.36 mmol/g.

Example 15

p-[-(*N*-Oxalyl-*L*-phenylalanyl-*L*-leucyl-glycylamido)-2,4-dimethoxy benzyl]-phenoxyacetylamido-SPOCC-resin.

The SPOCC-resin of Example 14 (200 mg, 0.072 mmol) was treated for 3 h with an aequeous solution of $NaIO_4$ (92 mg, 6 eq.) in sodium phoshate buffer (2.5 mL of 50 mmol NaH_2PO_4, pH 7) resulting in a solution of ca. pH 5. The resin was filtered off, washed with water, DMF, THF, and CH_2Cl_2 and analyzed. HPLC: r.t. = 25.6 min. MALDI-MS: Calc.(M = $C_{19}H_{26}N_4O_5$): 390.44. Found (MNa^+, MH_2ONa^+): 413.3, 431.4 m/z.

Example 16

Reaction of aldehyde-resin with phenyl lithium.

The SPOCC-resin of Example 15 (30 mg, 0.011 mmol) was treated with a solution phenyllithium (7 eq. in 1mL THF, 10 min at 0 °C, followed by 1.5 h at room temperature. Analysis of the reaction afforded a mixture of several product in the range between 24 and 37 min of the HPLC. Products in the range between 24 and 27 min displayed the mass of the starting material. Products in the range between 31 and 37 min displayed the mass of dimers of the starting material. MALDI-MS: Calc.(2xM): 780.88). Found: ((2xM)Na^+): 804 m/z. No side-reactions were observed involving the resin itself.

Example 17

p-[-(*N*-acryl-*L*-phenylalanyl-*L*-leucyl-glycylamido)-2,4-dimethoxy benzyl]-phenoxyacetylamido-SPOCC.

Methyl triphenylphosphonium iodide (69 mg, 0.171 mmol) was suspended in THF (2 mL) and cooled to -50 °C. Butyl lithium (0.154 mmol) was added. The salt dissolved and the color of the solution changed to a strong yellow-orange. After 20 min the solution was warmed to –10 °C. Resin from Example 15 (96 mg, 0.034 mmol) was added under argon to the stirred solution and reacted for 2 h. Preparative cleavage of the product (95 % TFA, 2 h) afforded a mixture of 2- and 3-hydroxypropionyl compounds. They were obtained through the hydration of the acrylamidic Wittig reaction product.

Example 18

***N*-(4-Carboxyl-but-2-*trans*-en-oyl)-(*L*)-leucyl-(*L*)-leucyl-glycyl-SPOCC-resin**

Lyophilized resin from Example 15 (90 mg, 0.041 mmol) was treated with toluene (1 mL) and triethylorthoformate (0.5 mL) for two h and was washed with dry toluene (6x). Triethylphosphonoacetate (41 l, 5 eq.) was dissolved in toluene (1 mL). At 0 °C butyllithium (4.5 eq.) was added. After 10 min the solution was added to the resin and reacted at ambient temperature for 90 min. After washing (DMF, THF, CH_2Cl_2) and drying the resulting resin was analyzed with MAS-solid phase NMR in $CDCl_3$. Cleavage of an analytical sample and HPLC-analysis was conducted. One portion of the resin (45 mg) was cleaved and isolated by preparative HPLC yielding the title product (5.2 mg, 64 %). r.t. = 28.0 min. ^{1}H-NMR, 250 MHz, D_4-MeOD):

= 0.88-0.98 (m, 12 H, Leu-Me), 1.6-1.75 (m, 6 H, Leu), 3.8-4.0 (2d, 2 H, ^2J = 17.8 Hz, Gly-), 4.4-4.5 (m, 2 H, Leu 6.68, 7.06 (2 d, 2 H, $^3J_{trans}$ = 15.5 Hz, olefinic protons). ^{13}C-NMR, 60 MHz, D_4-MeOD): = 131.9, 137.3 (olefinic carbons). ES-MS: Calc.: M ($C_{18}H_{29}N_3O_7$) = 399.20. Found: 400.2 m/z.

The usefulness of the polymers for peptide and glycopeptide synthesis are illustrated in the following examples.

Example 19

***N*-(9-Fluorenyl-methoxycarbonyl)-*L*-alanyl-*L*-seryl-*L*-phenylalanyl-*L*-leucyl-glycyl-SPOCC-resin.**

SPOCC-400 (326 mg, 0.58 mmol/g loading, 0.19 mmol) from Example 4 was reacted twice with a solution of Fmoc-Gly-OH (339 mg, 3 eq.), MSNT (338 mg, 3 eq.), and *N*-methylimidazole (MeIm) (68 l, 2.25 eq.) in CH_2Cl_2 (4 ml) each time for 45 min. After Fmoc-deprotection (20 % piperidine in DMF, 2 and 16 min) the glycinyl-residue was elongated with four Fmoc-amino acids (3 eq. of Fmoc-Leu-OH, Fmoc-Phe-OH, Fmoc-Ser-OH, and Fmoc-Ala-OH) which were activated with TBTU (2.9 eq., 177 mg) and NEM (4 eq., 127 l). All acylation reactions were performed after 15 min of mixing time for the reagents in DMF (4 mL), a reaction time on the resin of 3 h, and followed by Fmoc-protection. After final Fmoc-deprotection the resin was analyzed with HPLC and MALDI-MS.

Example 20

***N*-(9-Fluorenyl-methoxycarbonyl)-*L*-alanyl-*O*-(2,3,4,6-tetra-O-acetyl- -D-galactopyranosyl)-*L*-seryl-*L*-phenylalanyl-*L*-leucyl-glycyl-SPOCC-resin.**

Resin from Example 19 (100 mg, 0.04 mmol) was lyophilized from dry toluene (3 mL) in a speed vac over night. Tetra-O-acetyl- -D-galactopyranosyl trichloroacetimidate (0.12 mmol, 3 eqv.) was dissolved in CH_2Cl_2 (1.5 mL) and added to the resin. Under argon trimethylsilyl trifluoromethanesulfonate (TMSOTf) (120 L of a 1 M solution in CH_2Cl_2) is added and reacted for one hour. The resin is then filtered off, washed with CH_2Cl_2, THF, DMF, THF, and CH_2Cl_2, and dried *in vacuo.* The glycosylation procedure was repeated. Analysis is conducted with HPLC and MALDI-MS after cleavage with NaOMe in MeOH (0.02 M, 2 h). Complete glycosylation had been achieved. HPLC: r.t. = 20.1 min. MALDI-MS: Calc: M($C_{29}H_{45}N5O_{12}$): 655.7 Da. Found (MNa^+): 656 m/z.

Example 21

***L*-Alanyl-*O*-(-D-galactopyranosyl)-*L*-seryl-*L*-phenylalanyl-*L*-leucyl-glycinehydrazid**

Resin from Example 20 (2 mg, 0.035 mmol) is treated for 2 h with 20 % hydrazine in water. HPLC: r.t. = 22.0 min. MALDI-MS: Calc.: M($C_{29}H_{47}N_7O_{11}$): 669.7 Da. Found (MNa^+): 694 m/z.

The usefulness of the resins for enzyme reactions are illustrated in the following examples.

Example 22

L-Alanyl-(3-nitro)-L-tyrosinyl-L-glycyl-L-prolinyl-L-leucyl-glycyl-L-leucyl-L-tyrosinyl-alanyl-arginyl-(N^{ε}-2-aminobenzoyl)-L-lysinyl-glycyl-glycyl-SPOCC-resin

SPOCC-1500 from Example 3 (65 mg, 0.027 mmol) was treated twice with a solution of Fmoc-Gly-OH (41 mg, 5 eq.), MSNT (40 mg, 5 eq.), and MeIm (8 L, 3.75 eq.) in CH_2Cl_2 (4 mL) for 45 min. The resin was filtered off and washed with CH_2Cl_2 and DMF. The Fmoc-group was cleaved (20 % piperidine in DMF, 2 and 16 min) and it was again washed with DMF. The fully protected nonapeptide of the sequence Fmoc-A(NO_2)YGPLGL('Bu)YA(Pmc)R(Boc-Abz)KG-OH (43 mg, 3 eq.) was dissolved in DMF (4 mL) together with TBTU (6.8 mg, 2.9 eq.) and NEM (3.7 L, 4 eq.). After 15 min the latter solution was added to the resin and reacted for 3 h. The resin was extensively washed with DMF and treated twice with 95% TFA (10 min, 2.5 h) to remove side chain protecting groups. Subsequently the resin was washed with 95% acetic acid (4 times 5 min), 5% triethylamine in DMF (three times 2 min), DMF (twice 2 min), THF, and CH_2Cl_2, followed by drying *in vacuo*. The peptide was cleaved off the resin with .1M NaOH for 2 h for analysis. HPLC: r.t. = 32.0 min. MALDI-MS: Calc. M($C_{68}H_{99}N_{19}O_{19}$) = 1486.7 Da. Found: (MH^+, MNa^+-H_2O) 1487, 1493 m/z.

Example 23

Enzymatic cleavage of decapeptide bound to SPOCC-resin from Example 22. I. Subtilisin: The resin (2 mg) was treated with a solution of subtilisin (10^{-7} M) in pH 7 phosphate buffer (50 mmol NaH_2PO_4 in H_2O). After 15 min strong fluorescence under a UV-irradiation was observed. After three h the resin was washed (water, DMF, THF, CH_2Cl_2) and dried. One portion of the enzyme-treated resin (1 mg) was treated

with NaOH (50 L of a 0.1 M solution, 2 h) and the product analyzed by HPLC followed by mass spectrometry. The other portion of the resin (1 mg) was subjected to Edman degradation. The HPLC indicated complete cleavage of the starting peptide substrate. HPLC: r.t. = 22.0 min. MALDI-MS: Calc. M($C_{26}H_{42}N_{10}O_7$) = 606.7 Da. Found: 617.6 m/z. Edman-degradation (3 cycles): A, Abz-; R-; K-.

II. Matrix-metalloprotease-9: The resin (2 mg) was treated with a solution of MMP-9 (100 nM and 275 nM) in pH 7.72 buffer (buffer 17, obtained from CCBR, Ballerup) for 24 h. In both cases no significant fluorescence was observed. Cleavage and HPLC-analysis as described under I. yielded exclusively the starting peptide substrate.

Example 24

***L*-Alanyl-(3-nitro)-*L*-tyrosinyl-*L*-glycyl-*L*-prolinyl-*L*-leucyl-glycyl-*L*-leucyl-*L*-tyrosinyl-alanyl-arginyl-(N^{ε}-2-aminobenzoyl)-*L*-lysinyl-glycyl-glycyl-POEPS3-resin**

The resin obtained in Example 8 from mono- and bis-vinylphenylpropyl-PEG(1500) (0.1g, 0.02 mmol) was packed in a manual syringe synthesizer connected to a vacuum manifold and was esterified with Fmoc-Gly-OH using the MSNT procedure (Tetrahedron Letters 1988, **29**, 5871-5874). The Fmoc group was removed with 20% piperidine in DMF and the protected substrate Fmoc-AY(NO_2)GPLGLY(tBu)R(Pmc)K(Boc-Abz)G-OH (45 mg, 1 eqv.) was coupled to the resin using in situ activation with TBTU (1 eqv.) and NEM (1 eqv.). The resin was washed with DMF and dichloromethane and dried and protecting groups were removed during 2 h with 95% aq TFA. The resin was washed with dichloromethane and dried. The contents of amino acids were determined by quantitative amino acid analysis and Edman degradation sequence analysis and the expected sequence and amount was found. The peptide was cleaved off the resin with 0.1M NaOH for 2 h

for analysis. HPLC: r.t. = 32.0 min. MALDI-MS: Calc. M($C_{68}H_{99}N_{19}O_{19}$) = 1486.7 Da. Found: (MH^+, Mna^+-H_2O) 1487 m/z.

A beaded polymer from the oxetanylated macromonomer in Example

Example 25

Enzymatic cleavage of decapeptide bound to POEPS3-resin from Example 24. The resin from Example 24 (10 mg) was suspended in aqueous 50 mM bicine buffer (0.2 mM $CaCl_2$, pH 8.5, 100µL) and 10^{-6} M subtilisin Carlsberg (10 µL) in the same buffer was added. The reaction was followed visually under a fluorescence microscope (ex 320 nm; em 420-500 nm) and the reaction was complete in 60 min. Edman sequence analysis of the residual peptide on the resin showed the cleavage to be complete. The result was confirmed by cleavage with 0.1 M NaOH and HPLC analysis.

A similar experiment with the much larger MMP9 showed little cleavage only at the resin surface indicating the importance of matching the length of the PEG used for the resin preparation with the size of the enzyme to be investigated. Cleavage with 0.1 M NaOH and HPLC analysis as in Example 23 showed only non cleaved peptide.

Example 26

Synthesis of Silicon Polymeric Surfactant: Methacryloyl PEG 350 monomethylether. Methacryloylchloride (0.67 ml, 5.9 mmol) was added dropwise to a solution of PEG 350 monomethylether (2.0 g, 5.7 mmol) and triethylamine (1.7 ml, 12.2 mmol) at 0°C with stirring and exclusion of moisture. The reaction was stirred for 5h. The

reaction mixture was filtered and the solvent was evaporated *in vacuo*. The resulting pale white/yellow oil was used without further treatment.

Methacryloxypropylpentamethyldisiloxane (4.0 ml, 13.1 mmol) and methacryloyl PEG 350 monomethylether were dissolved in degassed chloroform (10 ml). AIBN (60 mg, 0.37 mmol) was added and the reaction vial was sealed and polymerised at 60°C for 48 h. The solvent was removed by evaporation *in vacuo*. The resulting polymer was a yellow paste and was dried under high vacuum and used without further treatment.

Example 27

Suspension Polymerisation of beaded Oxetan derived polymer by procedure A (SPOCC resin)

The surfactant (25 mg / g macromonomer) was dissolved in dichloroethane (0.38 ml / g macromonomer) and mixed with the macromonomer (4 g) under argon. After a homogeneous solution was obtained the solution was cooled in an ice bath and $BF_3{\cdot}OEt_2$ (0.1 ml / g macromonomer) was added with stirring and exclusion of moisture. After 2 min the mixture was added to silicon oil (20 ml / g macromonomer) at rt. stirring at 150 rpm. After 2 h at rt. the temperature was increased to 60 °C and the polymerisation was left over night without stirring. The resulting polymer particles were filtered on a sintered glass funnel. The beads were washed with dichloromethane, dimethyl formamide, methanol and water. The beads were treated with 6M HCl for 2 h at rt. and washed extensively with water, methanol, dimethyl formamide and dichloromethane. The beads were dried and sorted. Bead distribution (measured in methanol) ; X > 1000 µm : X > 500 µm : X > 300 µm : X < 300 µm (3 : 20 : 5 : 1). Total yield of beds: 2.9 g, 73%

Example 28

Suspension Polymerisation of beaded Oxetan derived polymer by procedure B (SPOCC resin prepared with addition of 3-methyl oxetan-yl methanol)

The surfactant (25 mg / g macromonomer) was dissolved in dichloroethane (0.38 ml / g macromonomer) and mixed with the macromonomer (prepared from PEG 1500, 2.3 g) and 3-methyl-3-oxetanemethanol (27µL-100µL) under argon. After a homogeneous solution was obtained the solution was cooled in an ice bath and $BF_3 \cdot OEt_2$ (0.1 ml / g macromonomer) was added with stirring and exclusion of moisture. After 45 sec the mixture was added to silicon oil (20 ml / g macromonomer) at rt. stirring at 200 rpm. After 2 h at rt. the temperature was increased to 60 °C and the polymerisation was left over night without stirring. The resulting polymer particles were filtered on a sintered glass funnel. The beads were washed with dichloromethane, dimethyl formamide, methanol and water. The beads were treated with 6M HCl for 2 h at rt. and washed extensively with water, methanol, dimethyl formamide and dichloromethane. The beads were dried and sorted. Bead distribution (measured in methanol) ; X > 1000 µm : X > 500 µm : X > 300 µm : X < 300 µm (6 : 17 : 7 : 0). Total yield of beds: 1.7 g, 74%

Example 29

(bis-(3-methyl-3-oxetanylmethoxy)-2-buten. 1,4-trans but-2-en diol (11 mmol) was dissolved in toluene and DMF (each 15 mL). Under stirring potassium hexamethyldisilazan (KHMDS) (22 mmol) was added at room temperature, after 15 min the solvents were removed together with HMDS at 50 °C waterbath with the

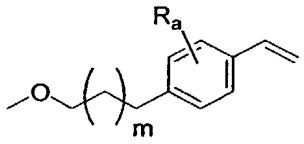
rotary evaporator. The remaining potassiated alcohol was redissolved in DMF (15mL). The mesylated oxetane derivative (24 mmol) was added in portions at room temperature and the reaction was heated for 12 hrs to 75 °C. After cooling to ambient temperature water (2mL) was added and stirred for 15 min in order to fully hydrolyze unreacted alkylating agent. The solvents were removed at 40 °C under reduced pressure. The remanens was disolved in CH_2Cl_2 and extraxted with water. The organic phase was dried and evaporated. Yield: 90 % of the title compound. The NMR of the product indicated the alkylation was quantitative.

Example 30

SPOCC-Resin formed by polymerization of oxetanylated PEG and a short temporary crosslinker. Oxetanylated PEG-1500 (1 to 20 mmol) prepared as in Example 2 and the crosslinker prepared in Example 29 (5-50 mol%) was dissolved under argon in an equal volume of CH_2Cl_2, cooled to –20 °C, and stirred with a magnetic stirring bar. Boron trifluoride diethyletherate (0.15 to 0.5 equiv.) was added and the solution stirred at –10 then allowed to varm to room temperature where the polymer formed. After 2 h the temperature was increased to 60 ° C overnight. The polymer was cut into pieces. These were swollen (CH_2Cl_2, 2 h) and then granulated through a metal sieve (1 mm pore size) employing a pestle. The granulated resin was washed carefully (CH_2Cl_2, THF, DMF, water, DMF, THF, CH_2Cl_2) and dried *in vacuo*. Loading was comparable with that of the polymer prepared in Example 4. The swelling capacity of the polymer product was considerably less than that of the polymer described in Example 4 depending of the amount of crosslinker added.

CLAIMS:

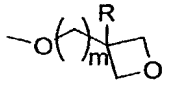
1. A macromonomer of polyethylene glycol having repeat units in the range 6-300 and having at least one end terminated by an ether group having the formula:



where m is an integer of 0-10, a is an integer of 1-4, and

R is H or alkyl or aryl or arylalkyl;

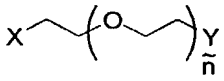
or having the formula



where m is an integer of 1-10, and

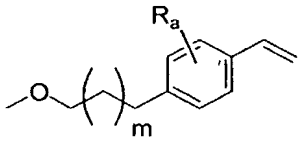
R is H or alkyl or aryl or arylalkyl.

2. A macromonomer having the structure:



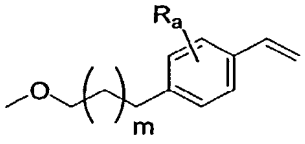
where ñ is a real number of 6-300,

and where X and Y each independently is a group of the formula



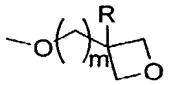
where a is an integer of 1-4, m is an integer of 0-10, and R is H or alkyl or arylalkyl,

or where X is –OH, and Y is a group of the formula



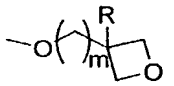
where a is an integer of 1-4, m is 0-10, a is as defined above, and R is H or alkyl or aryl or arylalkyl,

or where X and Y each independently are a group of the formula



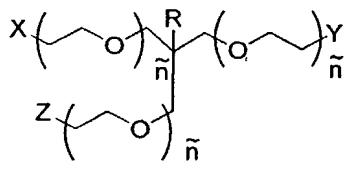
where m is an integer of 1-10, and R is H or alkyl or aryl or arylalkyl,

or where X is –OH, and Y is a group of the formula



where m is an integer of1-10, and R is H or alkyl or aryl or arylalkyl.

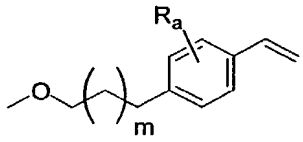
3. A macromonomer having the structure:



where R is H or alkyl or aryl or arylalkyl,

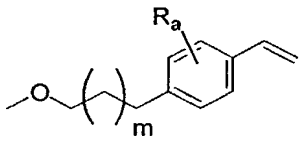
and ñ is a real number of 6-300 as defined above

and where X, Y and Z each independently is OH or a group of the formula



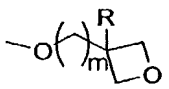
where a is an integer of 1-4, m is an integer of 0-10, a is as defined above, and R is H or alkyl or aryl or arylalkyl,

provided that at least one of X, Y or Z is a group of the formula



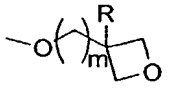
where a is an integer of 1-4, m is an integer of 0-10, a is as defined above, and R is H or alkyl or aryl or arylalkyl,

or where X, Y and Z each independently is are OH or a group of the formula



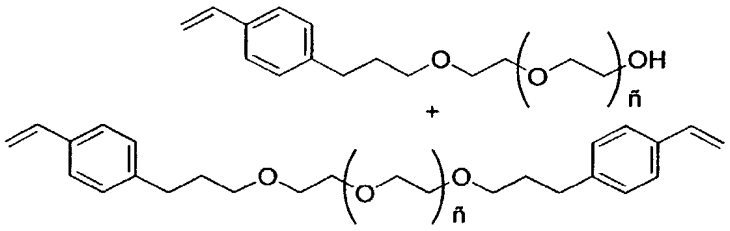
where m is an integer of 1-10, a is as defined above, and R is H or alkyl or aryl or arylalkyl,

provided that at least one of X, Y or Z is a group of the formula



where m is an integer of 1-10, a is as defined above, and R is H or alkyl or aryl or arylalkyl.

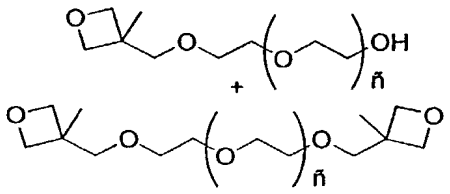
4. A macromonomer according to claim 2 which is terminated by a vinylphenylpropyl group and has the formula:



ñ = 6 - 300

where R_a and m are as defined in claim 1.

5. A macromonomer according to claim 2 which is terminated by an 3-methyloxetan-3-ylmethyl ether group and has the formula:

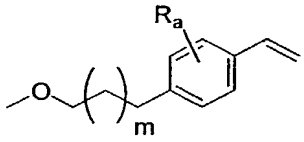


where ñ = 6-300

where R and m are as defined in claim 1.

6. A macromonomer according to claim 5, which has been acetylated or in other ways temporarily hydroxyl-protected on free hydroxyl groups.

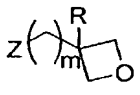
7. A process for the preparation of the macromonomers of claims 1 or 2 comprising reacting an alkali metal derivative of a polyethylene glycol having 6-300 repeating units with a halo substituted compound having the formula:



where Z is Cl, Br, I, toluenesulfonyloxy or CF_3SO_3

and where a is an integer of 1-4, m is 0-10 and R is H or alkyl or aryl or arylalkyl

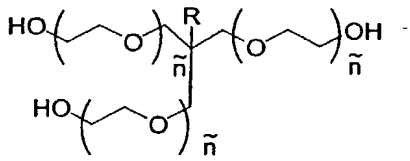
or having the formula



where Z is Cl, Br, I, toluenesulfonyloxy or CF_3SO_3

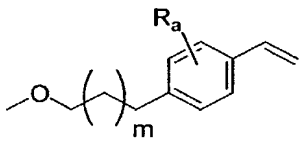
and where m is an integer of 1-10, and R is H or alkyl or aryl or arylalkyl

8. A process for the preparation of the macromonomer of claim 3 comprising reacting an alkali metal derivative of a polyethylene glycol having the formula: -



where R is H or alkyl or aryl or arylalkyl and ñ is 6-300

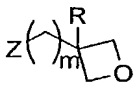
with a halo substituted compound having the formula:



where Z is Cl, Br, I, toluenesulfonyloxy or CF_3SO_3

and where a is an integer of 1-4, m is 0-10, and R is H or alkyl or aryl or arylalkyl

or having the formula



where Z is Cl, Br, I, toluenesulfonyloxy or CF_3SO_3

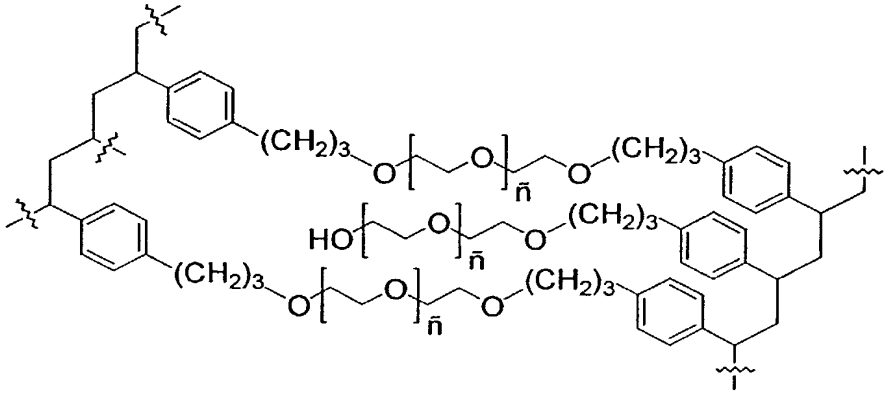
and where m is 1-10 and R is H or alkyl or aryl or arylalkyl

9. A process according to claims 7 or 8 wherein the alkali metal derivative is a sodium derivative.

10. A process according to claims 7 or 8 wherein the alkali metal derivative is a potassium derivative.

11. A cross linked polymer formed by the polymerisation of a macromonomer according to claim 2.

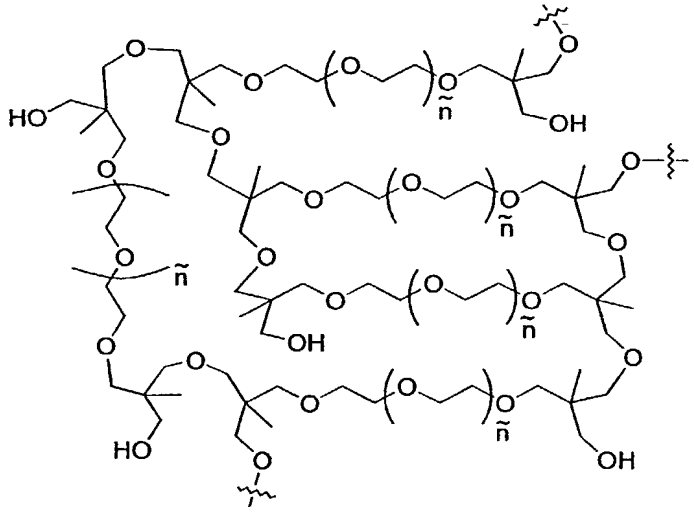
12. A cross linker polymer according to claim 11 wherein the macromonomer has the structure as claimed in claim 4, the polymerisation being initiated by a free radical catalyst and the polymer structure is represented as follows:



where $\tilde{n}$ = 6-300

where R_a and m are as defined in claim 1.

13. A cross linked polymer according to claim 11 wherein the macromonomer has the structure claimed in claim 5, the polymerisation is initiated by a cationic catalyst and the structure of the polymer may be represented by the structure:



where ñ = 6-300

where R is as defined in claim 1.

14. A crosslinked polymer according to claim 11 wherein the macromer used for its preparation has the structure of claim 6 and the per-*O*-acetylated or in other ways temporarily hydroxyl-protected polymer structure analog to the hydroxylated structure of claim 13 is obtained.

15. A cross linked polymer formed by the bulk polymerisation of a macromonomer of claim 3.

16. A beaded crosslinked polymer according to claim 12 made by reverse suspension- or spray polymerization

17. A beaded resin according to claim 13 or 14 formed by polymerization of droplets in silicon oil.

18. A beaded resin according to claim 13 or 14 formed by spray polymerization in a hot inert gas.

19. The use of polymers prepared according to claim 11 as supports for organic synthesis.

20. The use of polymers prepared according to claim 11 as supports for solid phase enzyme reactions.

21. The use of polymers prepared according to claim 11 as supports for synthesis of peptides, DNA, RNA and oligosaccharides.

22. The use of polymers prepared according to claim 11 as supports for peptide-, protein-, DNA- or RNA-ligation.

23. The use of polymers prepared according to claim 11 for chromatographic separations.

24. The use of polymers prepared according to claim 11 for affinity purification.

25. The use of polymers prepared according to claim 11 for protein immobilisation

26. The use of polymers according to claim 20 in which the enzyme interact with a substrate or an inhibitor linked to the support.

27. The use of polymers according to claim 11 in which the use involves release of a drug bound to the solid support.

28. Release of a drug according to claim 27 where the release is mediated by an enzyme.

29. The use of polymers according to claim 11 for solid phase magic angle spinning NMR-spectroscopy.

30. The use of polymers according to claim 11 for combinatorial chemistry.

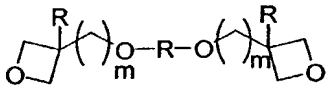
31. A beaded polymer according to claim 11 formed by suspension polymerization in silicon oil.

32. A beaded polymer according to claim 31 where the beads are stabilized by a surfactant

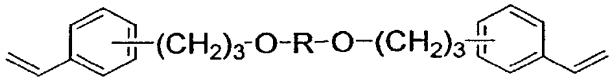
33. A beaded polymer according to 32 where the surfactant is obtained by radical polymerization of a mixture of acryloylated PEG-OMe and acryloyl propyl pentamethyl disiloxane.

34. A polymer according to claim 11 with addition of a short temporary crosslinker which may at a later point in time be selectively cleaved to result in expansion of the resin.

35. A polymer according to claim 34 where the short crosslinker has the structure



or



Where R is a alkyliden, aryliden, silane, siloxane thioether or ether bridge chemically susceptible to selective cleavage conditions.

36. A macronomer according to claim 1-6 prepared according to claim 7 or 8 but with the inversion of electrophile and nucleophile so that the tosylate or triflate or halide of PEG is prepared and reacted with the metal alkoxide of 3-methyl-oxetan-3-yl methanol or vinylphenylpropanol.

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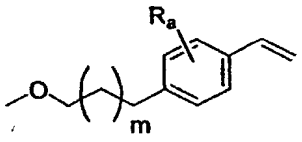
Without international search report and to be republished upon receipt of that report.

(54) Title: PEG–BASED MACROMONOMERS, CHEMICALLY INERT POLYMERS PREPARED THEREFROM AND THE USE OF THESE POLYMERS FOR ORGANIC SYNTHESIS AND ENZYME REACTIONS



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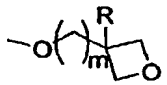

(II)

(57) Abstract

The present invention relates to macromonomers containing ethylene glycol repeat units, to chemically inert polymers prepared therefrom and to the use of such polymers in solid phase biochemical assays. A macromonomer of polyethylene glycol having repeat units in the range 6–300 and having at least one end terminated by an ether group having formula (I) where m is an integer of 0–10, a is an integer of 1–4, and R is H or alkyl or aryl or arylalkyl; or having formula (II) where m is an integer of 1–10, and R is H or alkyl or aryl or arylalkyl.

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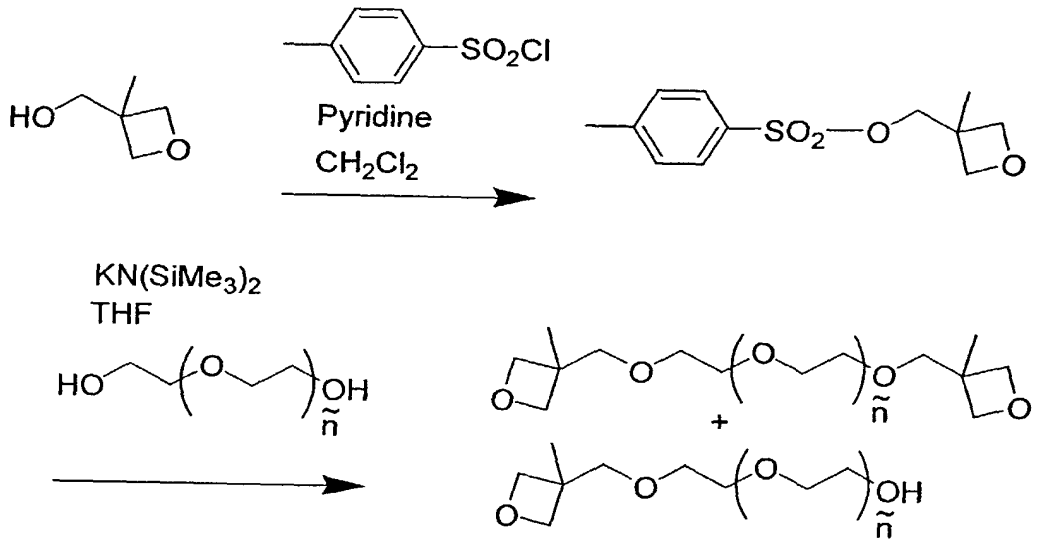
Fig 1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O
SO2Cl
Pyridine
CH2Cl2
SO2
O
O
KN(SiMe3)2
THF
HO
O
OH
n
O
O
O
O
n
+
O
O
O
OH
n

Fig 2

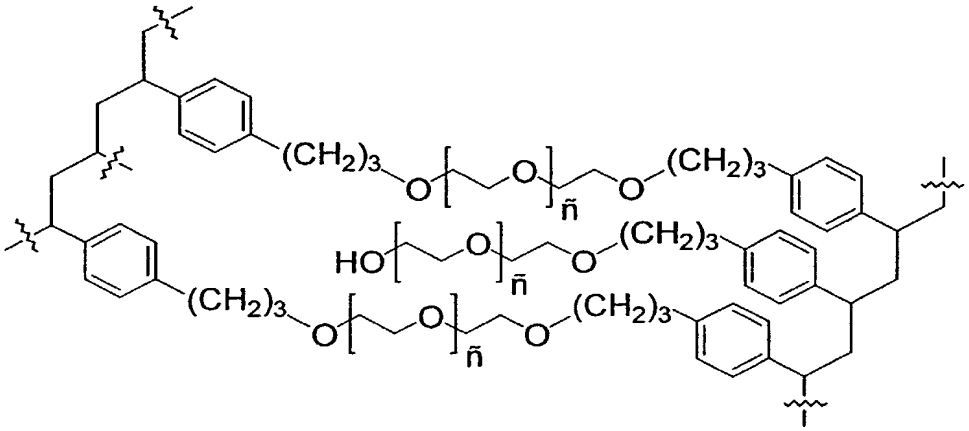


Fig 3

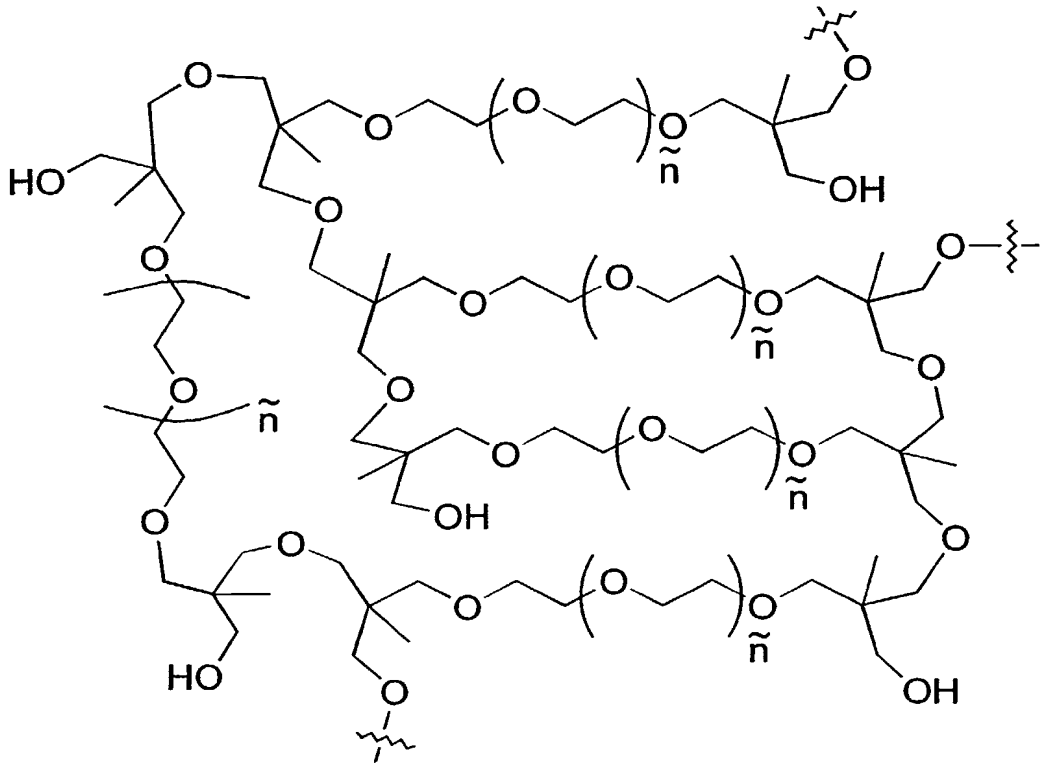
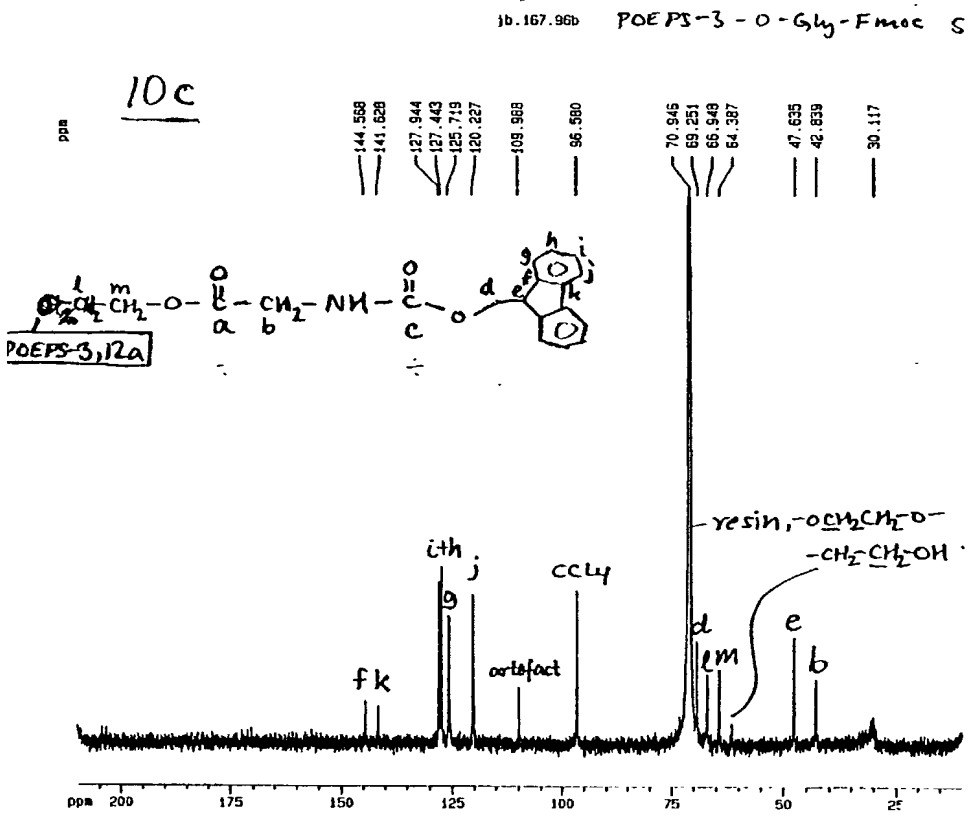


Fig 4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10c
ppm
144.568
141.628
127.944
127.443
125.719
120.227
109.988
96.580
70.946
69.251
66.948
64.387
47.635
42.839
30.117
POEPS-3,12a
resin,-OCH2CH2-O-
-CH2-CH2-OH
ith
j
g
CCl4
fk
artefact
d
lm
e
b
ppm 200
175
150
125
100
75
50
25

Fig 5

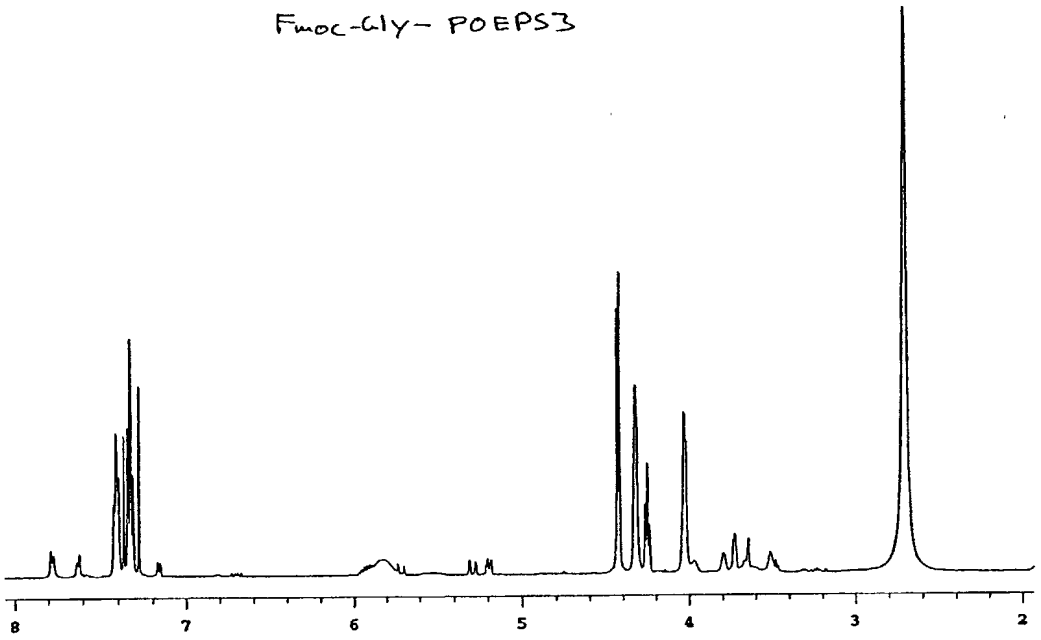

Fig 6

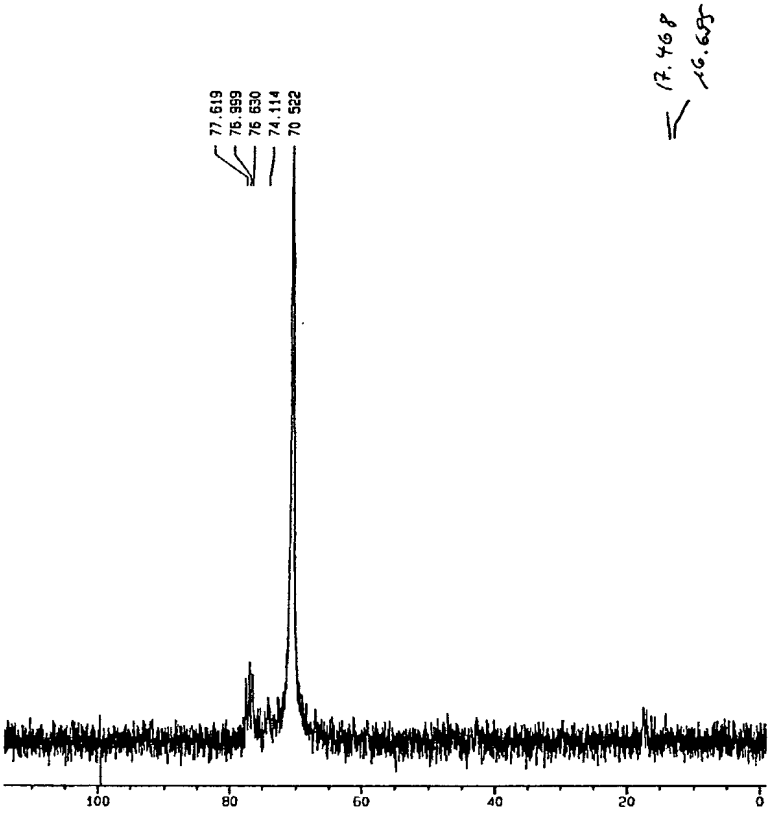

Fig 7

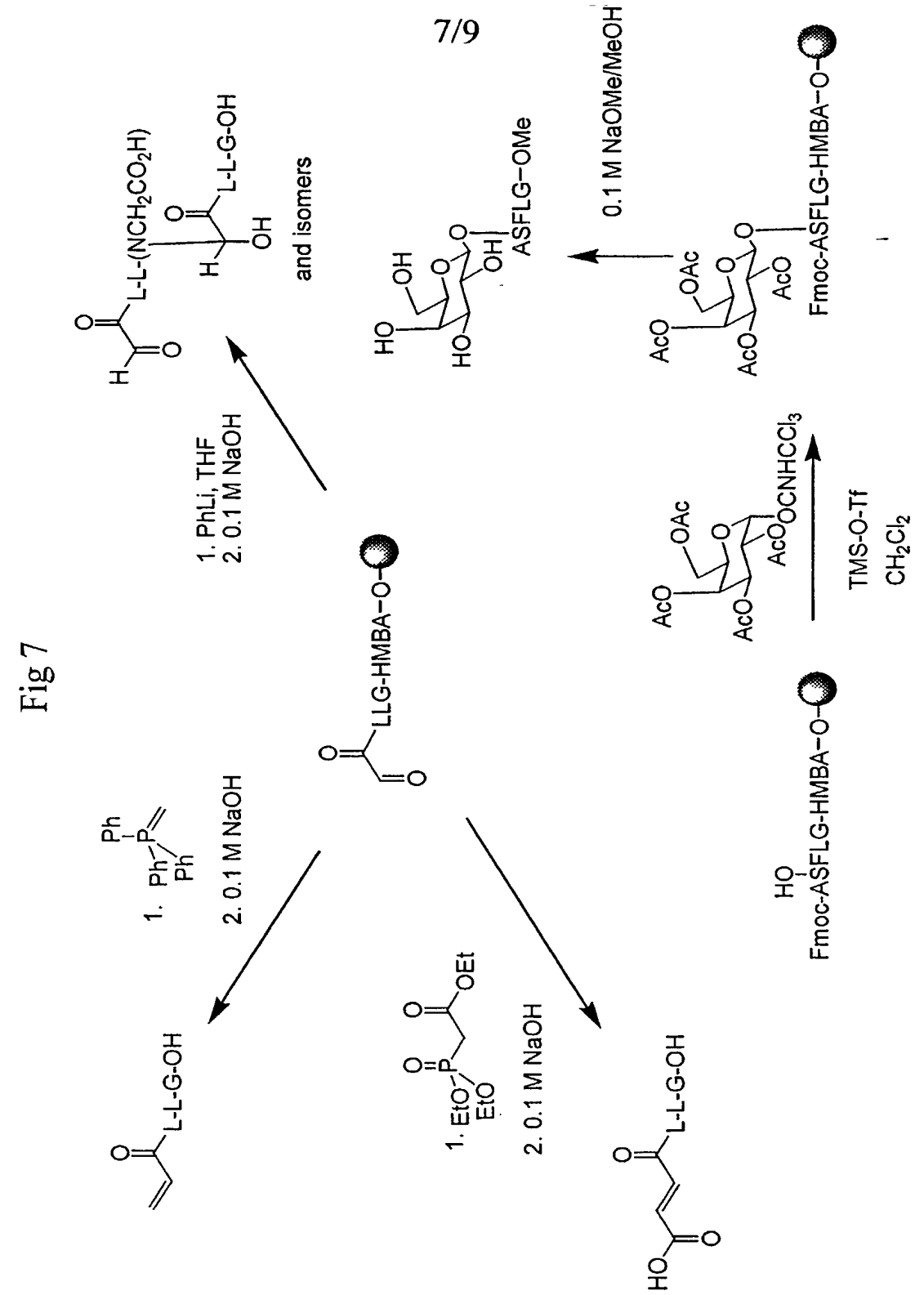
1. PhLi, THF
2. 0.1 M NaOH
and isomers
0.1 M NaOMe/MeOH
ASFLG-OMe
Fmoc-ASFLG-HMBA-O
TMS-O-Tf
CH_2Cl_2
LLG-HMBA-O
1. Ph3P=
2. 0.1 M NaOH
1. (EtO)2P(O)CH2
2. 0.1 M NaOH
L-L-G-OH
HO
Fmoc-ASFLG-HMBA-O

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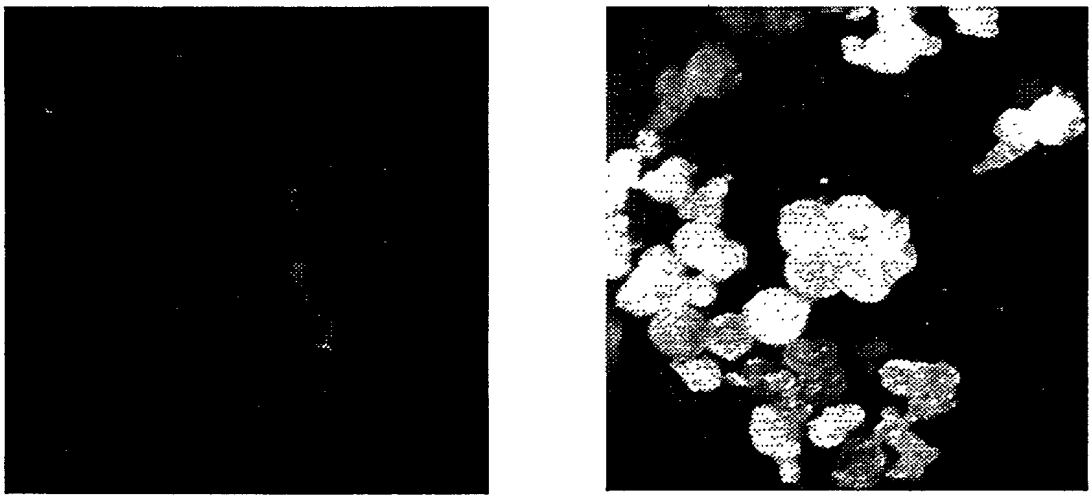
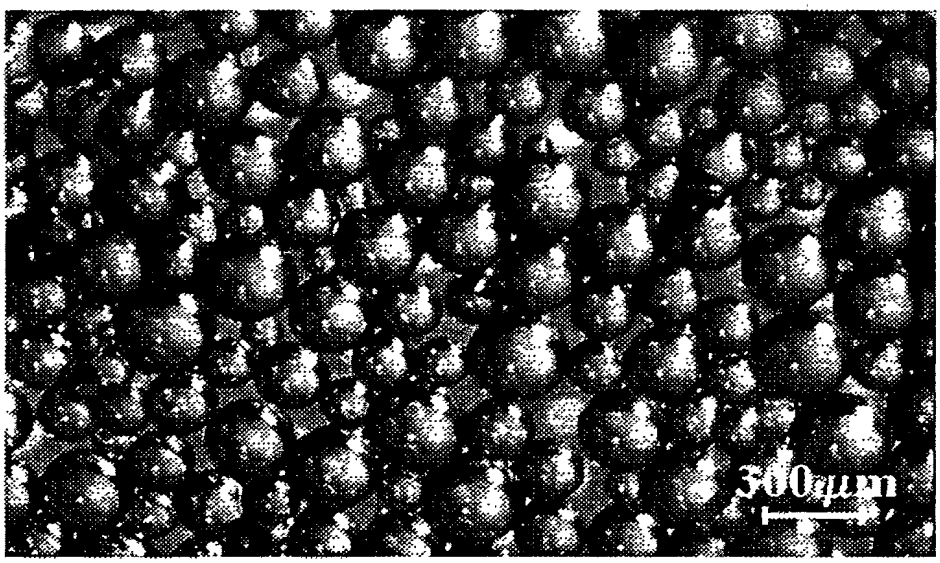
Fig 8



Before enzyme addition

1 h enzyme reaction

Fig 9



Atty. Dkt. No. 030307/0196

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I HEREBY DECLARE:

THAT my residence, post office address, and citizenship are as stated below next to my name;

THAT I believe I am the original, first, and sole inventor (if only one inventor is named below) or an original, first, and joint inventor (if plural inventors are named below or in an attached Declaration) of the subject matter which is claimed and for which a patent is sought on the invention entitled

PEG-BASED MACROMONOMERS, CHEMICALLY INERT POLYMERS PREPARED THEREFROM AND THE USE OF THESE POLYMERS FOR ORGANIC SYNTHESIS AND ENZYME REACTIONS

(Attorney Docket No. 030307/0196)

the specification of which (check one)

___ is attached hereto.

__X__ was filed on __September 28, 1999__ as United States Application Number or PCT International Application Number __PCT/DK99/00508__ and was amended on __March 23, 2001__ (if applicable).

THAT I do not know and do not believe that the same invention was ever known or used by others in the United States of America, or was patented or described in any printed publication in any country, before I (we) invented it;

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Prior Foreign Application Number	Country	Foreign Filing Date	Priority Claimed?	Certified Copy Attached?
PA 1998 01224	DENMARK	September 28, 1998	Yes	

I HEREBY CLAIM the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below.

U.S. Provisional Application Number	Filing Date

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U.S. Parent Application Number	PCT Parent Application Number	Parent Filing Date	Parent Patent Number

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Date	05/07/01

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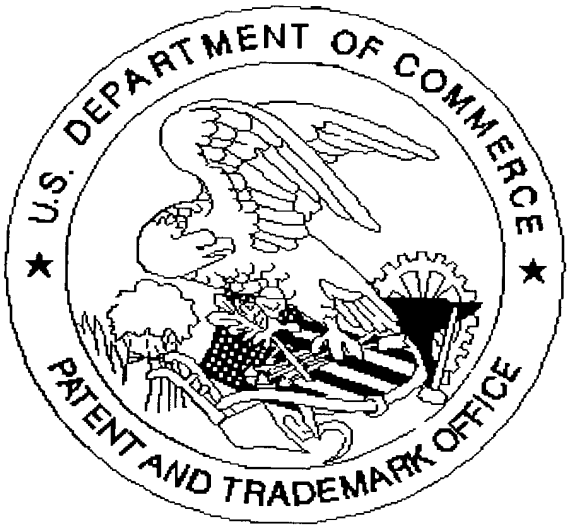

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